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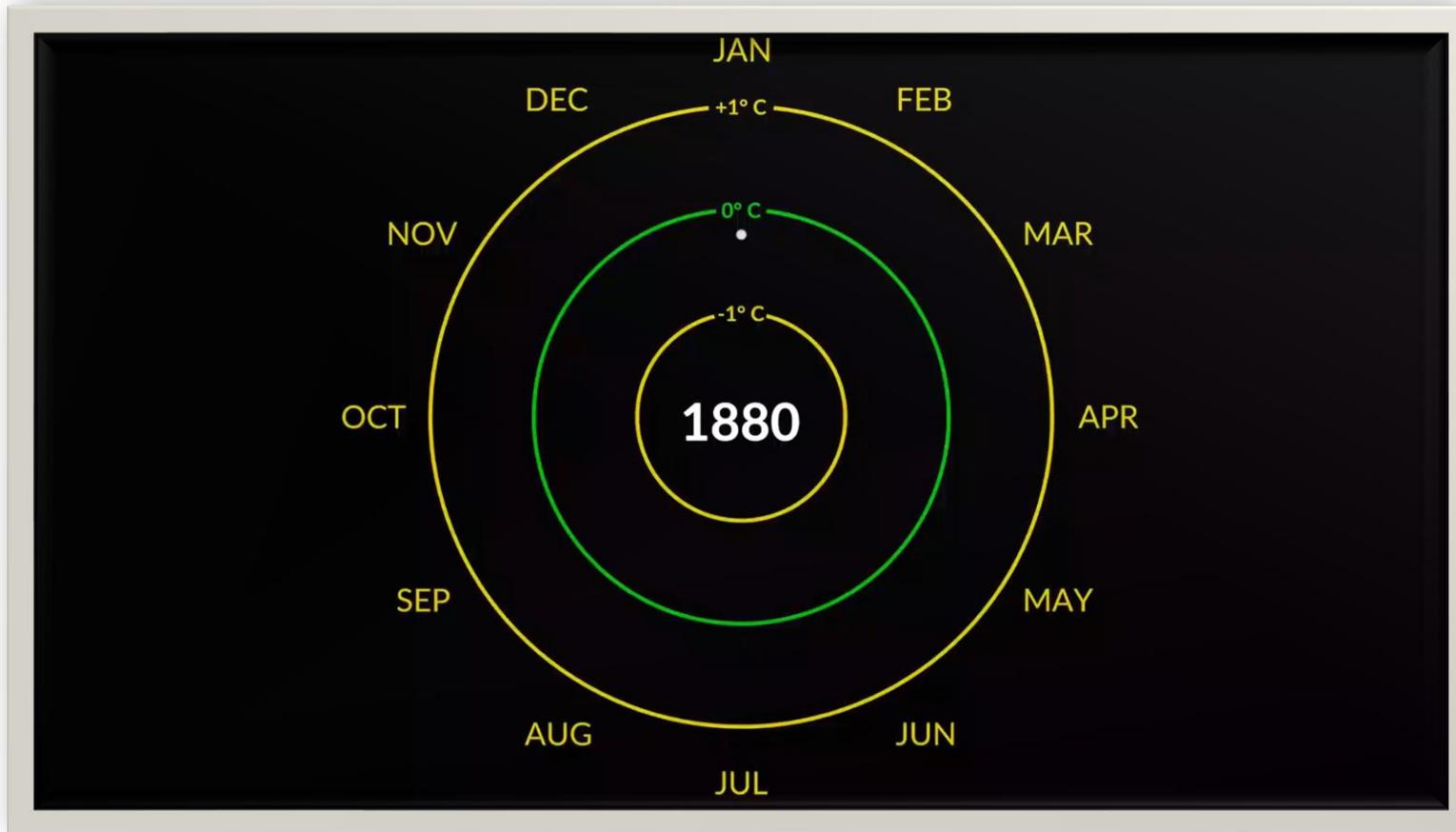
HASKEL HYDROGEN SYSTEMS

Hydrogen Refuelling Stations – Key considerations on your journey to H2 refuelling.

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BEFORE WE GET STUCK IN



- This visualization shows monthly global temperature anomalies (changes from an average) between the years 1880 and 2021
- Whites and blues indicate cooler temperatures, while oranges and reds show warmer temperatures
- As you can see, global temperatures have warmed mainly from human activities as time has progressed

[Video: Climate Spiral \(1880-2022\) – Climate Change: Vital Signs of the Planet \(nasa.gov\)](#)

THE NUMBERS ARE ADDING UP

Global Hydrogen Fueling Station Market Revenue (USD Million) Forecast by Region 2021-2028

Region	2028	CAGR (2021-2028)
North America	35.31	40.56%
Europe	63.56	32.27%
Asia Pacific	37.23	26.46%
Rest of World	30.25	54.02%
TOTAL	66.35	30.83%

Hydrogen is not the only solution.

It has its niche, and will work synergistically with all types of future energy.

Its part of the **solution** to Net Zero

- An extreme delta in stations from 2021 – 2028 expected
- Forecast has increased exponentially from \$56million to \$2,666 billion.

*Fortune Business Insights 2022 Global Market Analysis, Insights and Forecast, 2021-2028

WHY HASKEL?



- **World leading, mission critical expertise**
- **Over 200+ hydrogen project references worldwide**
- **Excellence in safety, quality and project execution**



Key Markets

Aerospace & defence

Oil & Gas

General industry

Hydrogen M

Specialty gas

HASKEL GLOBAL REACH

California
Manufacturing facility



Sunderland
Hydrogen Centre of Excellence, manufacture and test facility



Northern France
Manufacturing and test facility



Australia / NZ
Hydrogen station installation & commissioning and service facility



Global in region support network for commissioning, maintenance and service

SUPPORTING THE WHOLE PROJECT LIFE CYCLE

Launch of new hydrogen facility propels Sunderland's Haskel Europe into emerging sector

Europe's first facility dedicated to the testing of components could spark growth at the Sunderland plant



HYDROGEN REFUELLING

Comparable to conventional fuelling

- Safe, efficient and odor free
- Universal standard refuelling used worldwide
- Proven technology suitable for efficient infrastructure scale up
- Rapid refuelling capabilities similar to conventional liquid refuelling



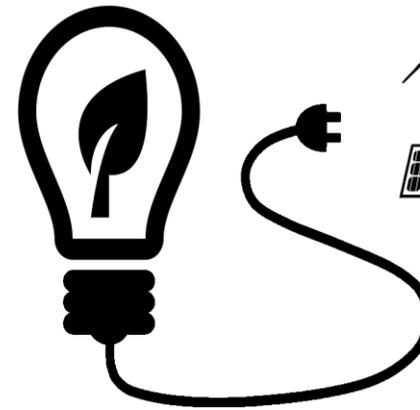
BASIC FUNDAMENTALS OF A HRS STATION

Compression, Storage and Dispensing



Dispenser

- Pre-Cooling
- Protocol
- Single/Multiple nozzles
- Simultaneous Dispensing



Hydrogen Supply

- Electrolyser
- Merchant H₂
- Pressure
- Flow

Storage

- High Pressure
- Medium Pressure
- Low Pressure
- Volume
- Type 1 - 4



Compressor

- Gas Booster
- Pneumatic
- Hydraulic
- Piston



WHY STANDARDISATION IS CRITICAL FOR GROWTH

Small decisions have a huge impact...

Current
Customer
Feedback

Downer

HIRINGA

TOTAL



arcola
energy

bonett

Shell
Hydrogen

1. The Hydrogen station needs to be capable of dual pressure and work with future higher flow rates (240g/s upwards!)
2. Stations are requiring a minimum of 1000kg of usable H₂, this point is critical as it drives huge CAPEX implications (ref efficiency in boosting reducing on site storage)
3. We have to be bold with our standard solutions, no movement unless large quantities are expected. Standardisation is critical.
4. Configurator and standard solutions that work in harmony. Commercial focus on – Nano, Nano-pro & Genos (Haskel is considering the commercial funding model).
5. How do we take advantage of a more efficient filling solution?

Haskel Hydrogen

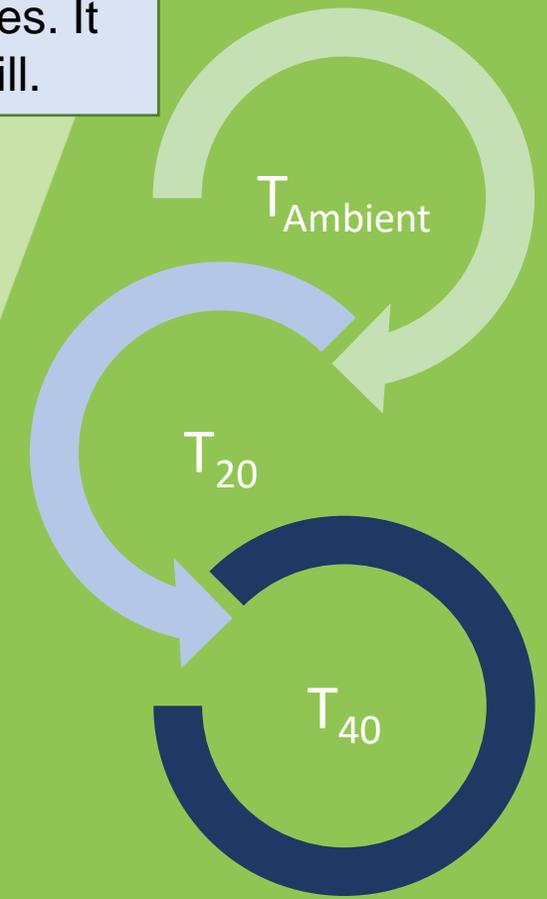
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HYDROGEN REFUELLING TECHNOLOGY

Customer Requests	Impact on decision
Fast filling 	<ul style="list-style-type: none"> • T_{ambient} - < 60 Minutes • T_{20} - < 10 Minutes • T_{40} - < 3 minutes
Increased flow rate 	<ul style="list-style-type: none"> • Regional fleets – 700bar trucks! • 3,000 kgs+ per day • Reduction in on site MP and HP storage • Up to 240g per second dispense
CAPEX/TCO 	<ul style="list-style-type: none"> • Compressor/system efficiency • IoT connectivity • Advanced service support features • Container based installation
Inlet condition 	<ul style="list-style-type: none"> • LP, MP, HP Storage • PEM Electrolyser • Grid/Pipeline • Liquid potential for consideration

Why is chilling important?
 Helium, Hydrogen and Neon are the only gases which have negative Joules Thomson coefficient. Meaning it acts differently to other gases. It affects the speed we can fill.

**SAE
 J2601**



HOW WE RESPOND - STANDARDISED REFUELLING STATIONS



NANO & NANO PRO

Small-Scale Cost-Effective Stations

- Up to 80kgs per day
- Slow refuelling (Ref J2601)
- Portable unit
- Ideal for small fleets or demonstrations
- Aimed at light duty vehicles
- Can refuel 1-2 HDV's with external storage

STANDARDISED REFUELLING STATIONS



STANDARDISED REFUELLING STATIONS



HIRINGA

GENO

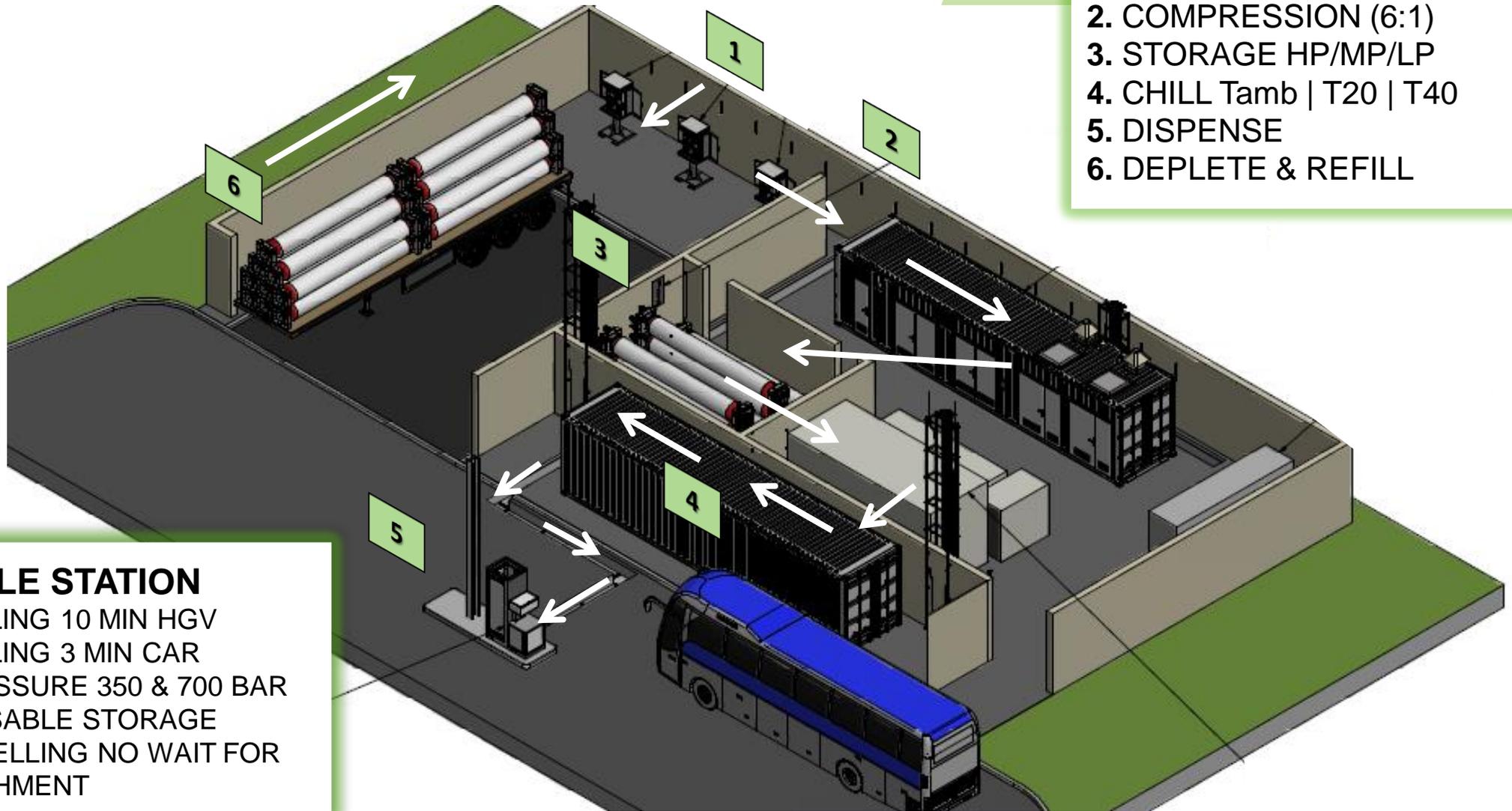
High-Volume, Large-Scale Stations

- 100kgs to 3000kgs+ per day
- Can achieve fast refuelling
- Permanent installation
- Servicing large fleets
- Heavy Duty Vehicles – 350bar
- Light Duty vehicles – 700bar
- Material Handling – 350bar

HOW IT WORKS – CASCADE FILLING

Standard T40 Station

1. INLET - SMR|TT|ELC|GRID
2. COMPRESSION (6:1)
3. STORAGE HP/MP/LP
4. CHILL Tamb | T20 | T40
5. DISPENSE
6. DEplete & REFILL



GENO STYLE STATION

- RAPID FILLING 10 MIN HGv
- RAPID FILLING 3 MIN CAR
- DUAL PRESSURE 350 & 700 BAR
- 1000KG USABLE STORAGE
- B2B REFUELLING NO WAIT FOR REPLENISHMENT

EMPOWERING COUNTRIES TO MAKE IT A REALITY



The Netherlands – With a €785 million subsidy for eight massive hydrogen facilities, the Netherlands is expected to increase its output of green hydrogen.

There are a number of funding schemes that have been established

The UK is sleepy when it comes to policy and investment.

The UK Government's Hydrogen Strategy which outlines the plans for the use of Hydrogen in the future. It announced funding worth £23 million to support the Hydrogen for Transport Programme which aims to support its use specifically for transport, this is a wider investment of **£102 million government backing for nuclear AND hydrogen innovation in the UK**

A clear disparity to other leading countries in Europe.

Millions Invested vs Billions.

recovery fund — includes €1.55bn for green hydrogen over the next three years.

coronavirus



[The Netherlands provides €785M subsidy for eight hydrogen projects - \(industryandenergy.eu\)](https://www.industryandenergy.eu)

[Germany's \\$1bn scheme to subsidise green hydrogen projects in non-EU nations gets green light | Recharge \(rechargenews.com\)](https://www.rechargenews.com)

[France pledges €20bn in tech, energy innovation before 2024 – EURACTIV.com](https://www.euractiv.com)

[£102 million government backing for nuclear and hydrogen innovation in the UK - GOV.UK \(www.gov.uk\)](https://www.gov.uk)

KEY TAKEAWAYS

1. Consider actually how fast you want to fill at the start of your project, this has huge CAPEX implications.
2. Stations need to become more efficient, we have to take advantage of a more efficient compression solution supplying a system that is protected against technical developments.
3. Storage & flow rate requirements for CASCADE filling has to change and become more efficient.
4. Standardisation is absolutely key to reduction in cost, lead-time and increases in innovation in the industry.
5. We have to challenge our government to bolster the strategic growth of this market – make it palatable
6. Continuous learning and data acquisition will drive future modernisation and efficiency of stations.

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**SUPPORTING GLOBAL REFUELLING
INFRASTRUCTURE FOR HYDROGEN MOBILITY**

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